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United States Department of the Interior, J. A. Krug, Secretary
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CERTAIN ASPECTS OF THE GERMAN FISHING INDUSTRY

REPORT II - QUICK FREEZING AND COLD STORAGE OF FISH

One of a series of six fishery leaflets* abstracted from BIOS FINAL REPORT No. 493, Item No. 22 prepared by Mr. W. H. Myles, Ministry of Fisheries, Dr. G. A. Reay, Department of Scientific and Industrial Research, and Lt. H. F. M. Farrer, Herring Industry Board, for the British Intelligence Objectives Sub-Committee, 32 Bryanstone Square, London, W. 1.

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Freezing Systems Employed

No actual quick freezing plants were seen, the quick freezing of fish having been carried out during the war on shore in Norway. The exceptions were freezing installations on the large steam trawler "Weser", now in Wesermunde, and on the factory ship "Hamburg" (5,500 tons), which was sunk in a British raid in March, 1941.

*F.L. 206 Fish Processing Machinery, F.L. 207 Quick Freezing and Cold Storage of Fish, F.L. 208 Smoke Curing of Fish, F.L. 209 The Preservation of Fish by Canning and Related Processes, F.L. 210 "WIKING EIWETISS" (A Protein Product Manufactured from Fish), and F.L. 211 Institute for the Utilization of Fish of the Federal Fisheries Agency (Artificial Ice, Spoilage in Fish, Anti-Oxidants, and Fish Meal & Oil Manufacture).

Four quick freezing systems have been employed in Germany:-

- (a) The Multi-Plate Froster ("Birdseye") by the Nordsee group at Trondheim and Bodo;
- (b) The "Z" Brine-Fog process of Zarotschenzseff, by the Lohmann group at Hammerfest and Svolvær;
- (c) The Air Blast system by the Andersen-Reemtsma group at Melbo;
- (d) The Contact system of freezing on pipes combined with Air Blast, employed by Dr. Schlienzen on the s.t. "Weser".

Multi-Plate Froster - Nordsee A.G., Wesermünde

Dr. Roloff of Nordsee A.G. gave information about their Multi-Plate freezing plant in Norway. The frosters originally came from Frosted Foods Ltd. before the war to Solo Feinfrost which got the rights in 1938 to construct frosters in Germany. The following plants were set up:-

	<u>Maximum Output. Tons of Fillet per day.</u>	<u>No. of Frosters</u>	<u>Storage Capacity</u>	<u>Remarks</u>
Trondheim	80	10	400 tons	5 compressors with common ammonia. Evap. temp. - 32 to - 34° C. Typical Birdseye Frosters.
Bodo	112	14	2,500 "	Plates cooled by Ca Cl ₂ brine and made of steel not aluminium, with special baffled channels for brine flow instead of usual tunnels. (Reason - shortage of aluminium during war). Temp. of brine - 36°C. in -30°C. out 2 units of high & low pressure compressors combined. 360,000 kg. cal. per day.

The frosters were in every case 10 station units. One froster dealt with 7 to 8 tons of fillets per 24 hours. The packages of fillet were 7 to 8 cm. (2-3/4" to 3-1/8") thick and of 9 kg. in weight, and were placed 9 per station i.e. 90 per froster, or 810 kg. total load. Freezing time was about 2 hours 40 minutes. The fillets were wrapped in cellulose film and the frozen blocks packed in cardboard cartons (unwaxed during the war). The temperature of storage was - 18° C.

The transport of the frozen fish to Germany was by train and small Dutch built refrigerated vessels (500 tons).

When asked about the future of frozen fish in peacetime, Herr Roloff said he felt that it should be possible to freeze a considerable portion of the Spring surplus and sell in the Autumn on a profitable basis. Roloff was also asked what he considered would be the future development of freezing - whether it would be on land or at sea. He stated that they had not had much experience of freezing at sea. The s.t. "Weser" was not a fair sample and the factory ship "Hamburg" which was built for freezing at sea was sunk only a fortnight after going to Svolvær. He was sure that freezing on land was much cheaper than freezing at sea, but it brought in the complication of obtaining the necessary foreign exchange. If Germany had not the wherewithal to purchase from abroad, this raised the question of freezing at sea. He was not prepared to commit himself as to whether in this case the future lay with the factory ship or the catching vessel.

Herr Roloff also stated that in pre-war days the Company had operated 10 frosters in Germany. They had frozen the ordinary fish landed from Iceland and the Norwegian Coast and found that it turned out in very good condition in the Autumn. He was asked what part of the catch was used and replied that for freezing they always chose the best - that would be fish of about 6 to 10 days old. They had no experience whatever of freezing Bear Island fish.

The question was put to Roloff as to the relative merits of the Birdseye system as compared with the Air Blast and "Z" systems. His reply was of a somewhat indefinite nature, but the gist of it was that the cost of an installation freezing, say, one ton of fish per hour was cheaper on the Birdseye system than on either of the two other systems. On the other hand, the cost of labour in filling the Multi-Plate freezer was greater than that of putting cartons on a band, as in the Air Blast method. One objection to the Air Blast froster was in his view the desiccation that occurs in freezing unless the fillet is enclosed in some kind of package.

"Z" Process - Lohmann & Co., Hamburg

Herr Lohmann met us in company with Dr. Schmidt. The latter is a lawyer and speaks good English; Herr Lohmann does not speak English.

They set up two of the five freezing establishments in Norway during the war. One was situated at Hammerfest and was destroyed by the Wehrmacht when they evacuated this area. Part of the installation was removed to Svolvær and again set up there.

The method of freezing employed was the "Z" Brine Fog process, associated with the name of Zarotschenzeff. Fillets of cod, the product of mechanical filleting and skinning, were wrapped in cellulose film in 6 kg. blocks and placed in boxes made of an aluminium alloy by Nordischer Maschinenbau. The box which prevents contamination of the fish with brine is in two pieces, a top and bottom and is closed by thumb screws. 54 boxes in 9 tiers were placed on a moveable metal trolley which completely filled the freezing chamber - i.e. a unit chamber load was 324 kg. Freezing time to -18°C . was 70 minutes. The brine had to be filtered, but after preliminary difficulties gave very little trouble. The "Z" process consists of atomising the brine (sodium chloride) into a very fine fog, which collecting at the bottom of the freezing unit is pumped back through the cooler.

At Hammerfest there were 12 freezing cabinets and 3 filleting machines (Nordischer Maschinenbau), but only 6 freezing cabinets and 2 filleting machines were transferred to Svolvær. At Hammerfest the output was 50 tons of fillet per day and at Svolvær 30 tons per day. The cold storage capacity at Hammerfest was 1,200 tons and at Svolvær 250 tons. Temperature of storage at both places was $-18^{\circ}\text{C}.$, using direct expansion ammonia grids. The freezing plant was made by Bergedorfer Eisenwerke, near Hamburg (30 km.) Mr. Johnston is being asked to obtain blue prints and specification from them: most of Lohmann's records were destroyed by bombing.

The transport of frozen fish to Germany was normally carried out in small refrigerated vessels of 500 tons. These were Dutch built vessels. Fish was carried in them at a temperature of -18° to $-22^{\circ}\text{C}.$ and went immediately into consumption. 40 per cent of what came to Germany was stated to have gone to the Wehrmacht.

The Svolvær outfit was stated to have been completed in six weeks. The installation was made in a disused salt fish works. The building used as a cold store was leased and was refrigerated to take 250 tons, little more than a week's output from the freezers.

Frozen fillet during the war sold for more than fresh fillet. It was said that fish froze quite well if two to three days old, but in the way the business had to be conducted in Norway it was sometimes 8 days old and it had not been carried on ice. The risks of the Norway business were very great and the price fixed for fillet was sufficient to cover this. The labour cost of frozen fillet in Norway was said to be 11 kroner per 100 kg. plus part of the wages of the German people there, which were paid in Germany, about 4 to 5 RM. per 100 kg.

Air Blast Process - Andersen & Co., Hamburg

This firm owned the factory ship "Hamburg" which was sunk in a British raid in March, 1941. The freezing plant on board was of the same description as that installed at the shore factory at Melbo, viz. a belt Air Blast freezer. The ship, of 5,500 tons, was fed by cutters and put through about 50 tons of fillet per day with storage for 800 tons. Fish meal and cod liver oil were made aboard. This size of unit and type of operation was not considered to be economic. A large fishing trawler fitted for freezing and by-product processing was thought to be a better proposition.

According to Herr Barez some special parts of the freezing apparatus are patented, but they do not amount to much. At the Melbo plant the fillets, cut by hand and skinned by machine from very fresh, headed fish, were packed with butter-paper liners in 5.5 kg. lots in collapsible metal moulds open at the top, the naked surface of the fish being made wet with water before freezing to minimize desiccation. The rough dimensions of the block were 5.5 cm. x 34 cm. x 42 cm. (2.2 in. x $13\frac{1}{2}$ in. x $16\frac{1}{2}$ in.).

Appendix 5 shows a drawing of the belt Air Blast freezer with dimensions as constructed by Linde & Co. The Central Fisheries Office is being asked to obtain full specifications and blue prints. Two tiers each of 3 or 4 packed moulds, placed lengthwise or breadthwise across the frame as desired, were carried

on open angle iron frames by the moving belt along the tunnel through a cross-blast of cold air. The speed of the belt was kept constant, but when the fish had been warmed up as in summer, the moulds were stacked in threes; when cold, as in winter, in fours i.e. at a somewhat higher rate of feeding.

The drawing shows the position of the 6 axial flow fans, the two smooth tubed cooling units and the direction of air circulation which was 50,000 cub. metres per hour, giving a linear speed through the fish of about 6 metres per second. Air in the two halves of the tunnel was kept separate so that nearly all frosting of the cooler occurred nearest the end of the tunnel at which the fish entered. This was thought to increase the efficiency of cooling the fish since the effect of lowered temperature gradient between the fish and the pipes as the fish cooled was offset by diminishing insulation of the pipes with frost. The two flooded ammonia coolers were linked to a common surge drum. The evaporation temperature was -45°C . to -47°C . and air was delivered at -45°C . and returned to the cooler at -42°C . Two double-stage 45 H.P. compressors were used for each tunnel. The fish were frozen to about -22°C . on the outside in about two to three hours depending on the initial temperature of the fish. The whole plant consisted of three tunnel units and the total throughput per day, allowing for a few hours de-frosting of the coolers with warm ammonia, was about 48 tons. Each tunnel during actual freezing put through about 0.8 tons per hour.

The frozen fish were easily removed from the moulds by unclipping them at the corners and the blocks were then packed in cardboard cartons (2 pieces lid and bottom - waxed, when obtainable). The fish were stored at -18°C . in a store of 1,500 tons capacity. At times storage extended to 8 months with satisfactory results. The frozen fish packing room was run at -12°C .

The following rough cost analysis was obtained from Herr Barez:-

	<u>Kroner</u>
Raw material	4,831,000
Wages and salaries	1,081,000
Current, Oil, Maintenance	295,000
Packing	692,000
Depreciation at 25%	1,321,000
Sundries	<u>60,000</u>
TOTAL (given by Herr Barez)	<u>8,476,000</u>

The total quantity of fish represented above was 8,578,000 kg. (gutted and headed fish as delivered). Cod represented 75 per cent of the fish frozen. Other species were saithe, tusk and ling.

This firm did all its filleting by hand and reference to the records showed a yield of 54.1 per cent from cod and 59.2 per cent from saithe.

Contact Freezing on Pipes with Air Blast - Dr. Schlienz of
Kuhl und Lagerhaus, Wesermunde

Dr. Schlienz runs a large general cold store of 6,000 tons (6 floors of 4 to 5 rooms). He has pioneered the freezing of fish in Germany by brine freezing (Ottesen process) and the freezing of fillets. (See his well known book of 1930 in the Muster Betriebe Deutscher Wirtschaft Series No. 16, "Die Fischwirtschaft, Kuhlfish A.G. Wesermunde).

Dr. Schlienz was Managing Director of the Company that ran the freezing trawler "Weser" which was inspected. Dimensions of the vessel were 57.82 x 8.58 x 4.43 metres, i.e. 190.8 ft. x 28.3 ft. x 14.6 ft. The vessel was built first as an ordinary trawler, sunk in 1942, raised, lengthened by two to three metres, and fitted with apparatus for filleting, freezing and storing fish and for reduction of offals. Complete plans of the ship and the layout are in Dr. Schlienz' house in the Black Forest in the French Zone. We have asked Central Fisheries Office, Hamburg to obtain copies of these plans and forward them to B.I.O.S. in the United Kingdom. The ship when seen had been partly stripped of filleting and freezing plant.

Two ammonia Borsig compressors each of 45,000 kg. cal./hr. capacity were housed on the main deck below the wheelhouse. These supplied ample power for freezing fish and for cooling brine for refrigeration of the storage room. The Centre Fishroom (roughly 5 x 8.5 x 2.5 metres) was air insulated, had a glass roof for lighting and was used as a filleting and packing room. Here fish delivered from the deck by chute were put through one of the Nordischer Maschinenbau filleting machines, the offal being taken by conveyor belt to the After Fishroom in which a fish meal plant was installed. Provision was made for a skinning machine to be installed in the processing room but this was not done. The reason may have been the shortage of space, but it was explained that the vessel was confined to work in the Baltic where fish is thin-skinned admitting of the fillets being packed with the skins on.

On a packing table the fillets were packed in 1 kg. blocks (about 2 in. thick) and wrapped in parchment paper. The blocks were packed in metal trays measuring about 39 in. x 28 in. and carried forward to the two freezers which were placed on either side of a passageway leading to the Fore Fishroom which formed part of the cold store.

The freezer consisted of 15 closely arranged tiers of ammonia piping with 10 intervening spaces to take trays in single layer. Freezing was effected by conduction, but air was kept in circulation amongst the pipes by two fans with appropriate baffle arrangements. The plant was based upon Heckermann's ideas. (See B.P.489,939). It also resembles the "Murphy" freezer in principle. Ammonia was evaporated at -32°C . to -35°C . The time required to bring the fish down to -23°C . was about $1\frac{1}{2}$ to 2 hours. The pipes were defrosted each day with steam for about half an hour to an hour. The two freezers together put through 1.6 tons of fillets (4 tons of gutted fish) per hour. The frozen blocks were packed in cartons containing 36 kg. and stored in a brine cooled store insulated with 9 in. cork, at -20°C ., holding in all 80 tons of fillet. The storage space comprised the Fore Fishroom and also space beneath this coming aft underneath the freezing and packing room right on the bottom of the ship.

An offal plant of normal Schlotterhose type occupied the After Fishroom. From two feeding hoppers material entered a steam cooker 5½ metres long with worm propulsion, heated at first by direct steam injection and further along the tube by steam jacket at a pressure of 1.6 atmospheres. The two underlying driers were of about the same length as the cooker. The plant put through about 12 tons of offal per 24 hours. The dried material was stored without grinding.

This most interesting experimental ship ran for about two years (16 trips), all on poorish fishing grounds, except for two trips for Baltic cod. We were informed that processing on board was possible in all weathers in which the vessel could fish - there was no serious inconvenience in working in 6 to 7 degrees of storm. The plant for freezing, filleting, and meal manufacture cost about 450,000 RM. and a subsidy for this amount was obtained. At the end, the deficit was some 120,000 RM., though two good trips had shown a profit of 25,000 to 30,000 RM. each. The repair costs were heavy. The boiler was not large enough and was damaged. The vessel was too small, had insufficient storage space and was confined to unremunerative fishing grounds. The experiment should indicate the lines on which further investigation might be made. Dr. Schlienzen believes in the future of refrigerated trawlers, and considers that a good size of ship would be one of 70 metres in length and 10 to 12 metres beam. A ship of this size might cost 700,000 to 800,000 RM. and the plant about 400,000 to 500,000 RM.

Dr. Lucke and Dr. Luneburg of the Institut fur Fischverwertung, Wesermunde

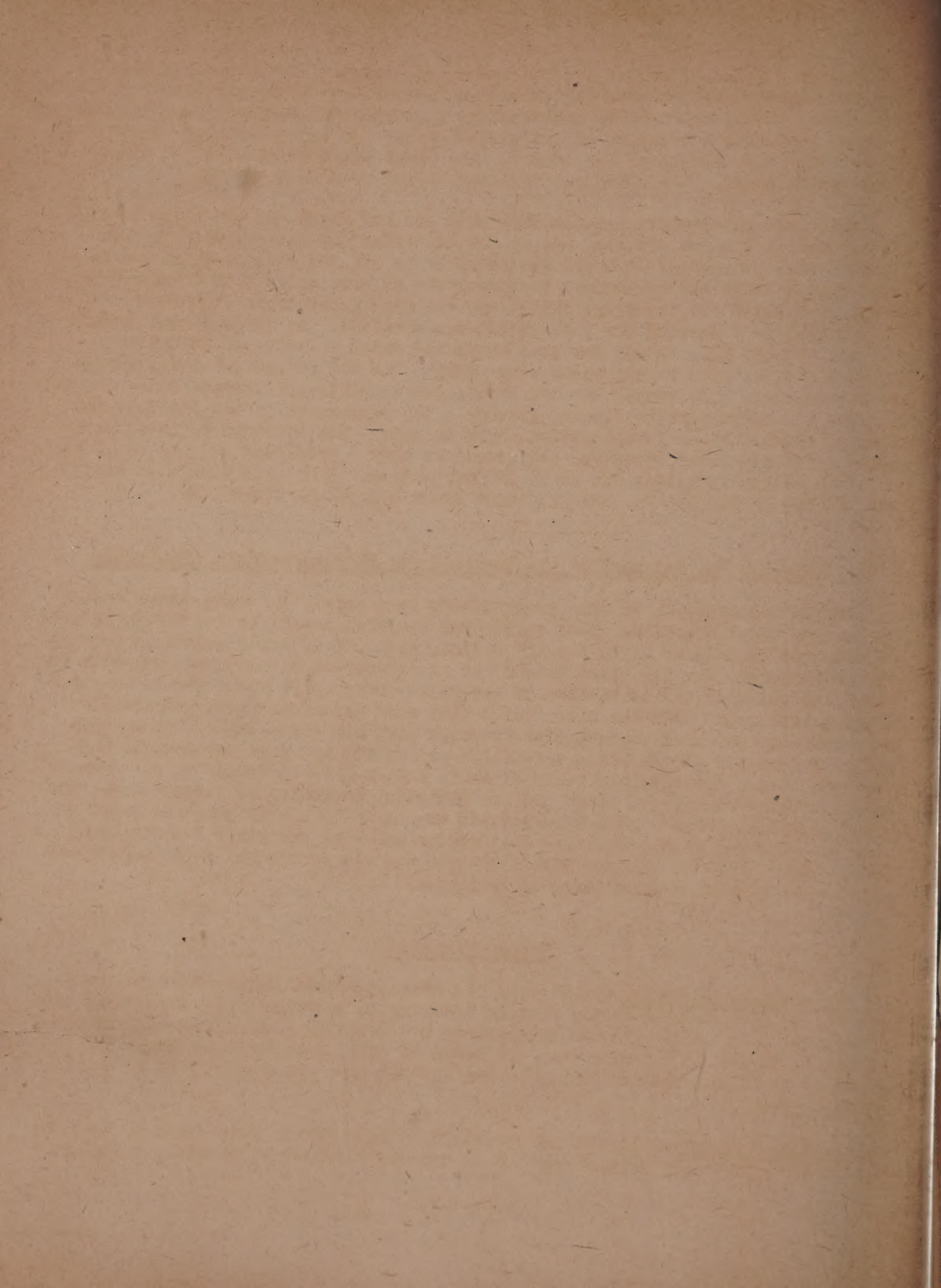
During a discussion on fish preservation in general, the above-named made a few remarks about freezing. They considered the best result in the Norway project was obtained by Lohmann using the "Z" method, the fillets being packed in protective containers. The Air Blast method was considered to be somewhat dangerous for fatty fish owing to the initiation of oxidative change. It was a method too that occupied more space than the other two. They were acquainted with Heckermann of Bremen who has patented contact pipe freezers with air circulation. These were primarily designed for freezing vegetables and fruits and some development had occurred. None, however, had taken place in the fish field except in the case of the s.t. "Weser" where the plant had the important advantage of compactness. They agreed with Heckermann's idea of arranging the pipes in a cold store as racks to carry the produce, thus preventing desiccation and even promoting deposition of frost. This, however, had not been developed and was considered to be uneconomic owing to the amount of room taken up by piping.

Recommendations

Re Freezing in Norway--In view of the growing general interest in the quick freezing of fish evinced by the fishing industry in Britain, it is considered that it would be well worth while to investigate the freezing plants installed by the Germans in Norway if and when they are again in full, regular operation. The season of the large Spring fishing in the Lofoten area would appear to be a suitable time.

Re s.t. "Weser"--A Special study should be made of the plans of s.t. "Weser" in connection with any British project to develop freezing on board a trawler.

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Barry - d. - Andersen & Co

Hamburg



Report II.

Appendix 5.

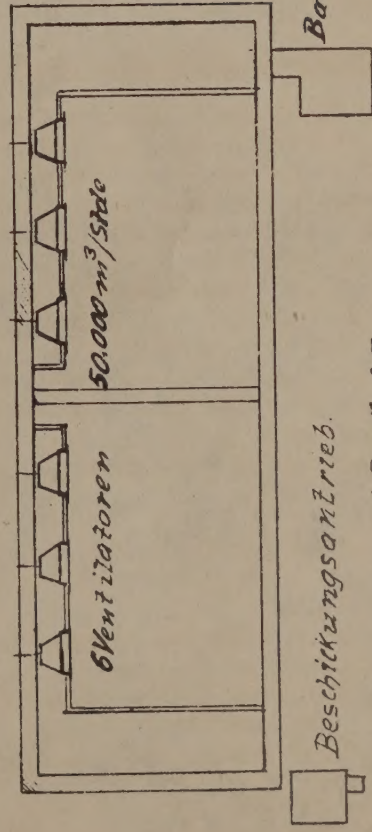
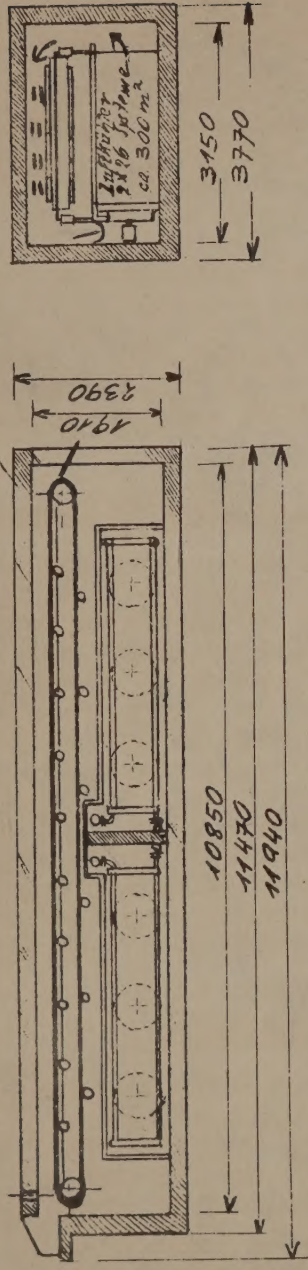
Linde-Bandgefrierapparat.

Maßstab 1:100

400 x 600 mm



Isolierung 250



Beschickungsantrieb.

Bandantrieb

Hamburg, am 1. Sept. 45.

Gähler

